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SOVIET MACHINE BUILDING

NO. 10

SELECTED TRANSLATIONS

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Introduction

This is a serial publication containing selected translations of articles on the machine building industry in the Soviet Union. This report contains translations on subjects listed in the table of contents below.

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1. The Present Status and Future Trends in the Development of Methods for the Nondisruptive Testing /Inspection/ of Materials

/This is a translation of an article written by S. T. Nazarov, S. M. Rozhdestvenskiy and D. S. Shrayber in Zavodskaya Laboratoriya (Plant Laboratory), No.7, 1959, pages 771-778; CSO:2900-N/8 (10)./

The role of the methods of nondisruptive testing in the Seven-Year Plan of the Development of the National Economy of the USSR in 1959-1965 is growing by leaps and bounds. In the last few years these methods have been broadly introduced into industry and they are becoming an obligatory, inseparable link in the technological process.

The most widely used inspection methods are those based on the utilization of various types of penetrating radiation (roentgen and gamma rays, ultrasonic vibrations), magnetic and electric properties of material, and the phenomena of capillarity.

One of the oldest and most commonly used methods of nondisruptive inspection is the X-ray photographic method: its principal advantage consists in the visibility of the results of inspection combined with a sufficient sensitivity for detecting the latent macroscopic flaws in the exposed material. However, inspection by this method is low-productive and expensive.

And inasmuch as the present-day industry is characterized by an ever-increasing automation of production processes, therefore the above-mentioned shortcomings make it necessary to explore the ways and means of perfecting X-ray examination, chiefly through improvements in X-ray equipment and the replacement of the photographic method by new flaw-recording methods.

The /X-ray/ apparatuses finding the widest acceptance in industry are those of the RUP-1 and RUP-2 medium-voltage 200-kilovolt types, which are used in many plants for inspecting parts of castings and weldments of steel as much as 50 mm thick, and of the RUP-3 400-kilovolt type, which are used for inspecting steel products up to 100 mm thick and heavy or light alloys of an equivalent thickness.

Less widely used are betatrons, which can be used for inspecting castings or products of steel as much as 500 mm thick.

It should be noted that hitherto our industry has been underestimating the possibility of employing betatrons for inspecting the joints executed by electro-slag welding on steel products.

An effective means of broadening the opportunities for X-ray examination lies in the perfecting of the methods of the recording of the radiation emitted during the exposure of materials.

Of special interest to X-ray defectoscopy is the possibility of utilizing the electron-optical converters (EOP) which, in combination with television attachments, could ensure the modern automated industry with a high-grade and rapid X-ray inspection. In this case, a beam of X-rays passes through the product to be inspected and falls on an EOP where it causes the glowing of the first screen, which releases electrons from the photocathode attached to that screen. At every point of the photocathode the number of electrons liberated during a time unit is proportional to the luminosity of the corresponding point on the screen and, consequently, to the intensity of the X-ray beam.

Thus, a beam of X-rays of varying intensity is converted to a beam of electron rays with an analogous density distribution over the cross section of the beam. The liberated electrons of the photocathode are accelerated by the high voltage impressed to the anode and collide with the second fluorescent observation screen, thus causing it to glow brightly. The image thus obtained is smaller than the image on the first fluorescent screen, but its brightness is more than 1,000 times as high. The image on the screen is viewed through an optical system providing an approximately ninefold magnification without any appreciable light losses.

From the screen of the EOP the image can, by means of the devices applied in television engineering, be transmitted over a considerable distance, which makes it possible to assure reliable protection from the harmful effect of X-radiation.

At inspections employing an EOP the sensitivity in detecting flaws in aluminum up to 20 mm thick and in steel up to 10 mm thick is close to the sensitivity of an X-ray photograph. The inspection of welded seams on aluminum up to five mm thick can be conducted at the speed of five meters a minute. Thus, the next task of X-ray defectoscopy is to introduce this method in industry.

An interesting improvement on X-ray photographic inspection is the utilization of the photoconductive properties of transistors for obtaining an electron-diffraction image of an object at X-ray inspections by means of xerography. The physical nature of this method consists in that the X-rays passed through the product to be inspected act

upon a charged semiconductor coating on a plate and form a latent electrostatic image. The latter manifests itself through some electrified powder which provides a visible image of the irregularities in the exposed product. The employment of xerography in lieu of the photographic method of X-ray inspection simplifies the techniques of inspection and cuts its costs.

The valuable qualities of radioactive isotopes serving as sources of gamma and beta radiation (portability and simplicity of apparatus design, simplicity of exposure techniques, feasibility of exposure in plant shop and under field conditions in the absence of sources of electrical energy) make it possible to utilize them in many cases for industrial defectoscopy, despite their major shortcomings.

The greatest use in defectoscopy was found for cobalt-60, iridium-192, europium-152--154, selenium-75, and thulium-170. For industrial defectoscopy a valuable gamma emitter can only be an isotope which has sufficient radiant energy and sufficient dimensions of focal spot to ensure maximal sensitivity to the detection of flaws in a given material of a given thickness. Inasmuch as a universal source of gamma rays suitable for inspecting various materials of various thickness cannot exist, therefore in industry it is necessary to use isotopes with various radiant energies. Unfortunately, for a host of reasons, this is not done and the valuable method of gamma-defectoscopy often unjustifiably disappoints the workers of industry.

For exposure of steel products of various thickness (over 60 mm) it is possible to use cobalt-60, and for the products 10 to 60 mm thick -- iridium-192 and europium-152 -- 154. As for the steel products less than 10 mm thick and the products of light alloys as well, it is necessary to employ isotopes with a very soft gamma radiation, e. g., thulium-170 and europium-155.

The isotopes with a radiant energy suitable (in terms of sensitivity) for a given material but endowed with a short half-decay period involve difficulties in operation because of the necessity of frequent replacement of the preparation and rapid increment in exposure time as a result of the decline in activity of the preparation.

The long duration of exposure time when using preparations with a low activity strongly reduces the productivity of exposure; on the other hand, the augmentation of the activity of a preparation harms the quality of the exposures, because it results in increasing the radiating surface of the source and, moreover, it intensifies the harmful effect of gamma rays on the tending personnel.

The above shortcomings of gamma defectoscopy are of

major importance in mass inspection under industrial-plant conditions and of lesser importance in sampling inspection, especially under field conditions.

An increase in the productivity of the method of gamma defectoscopy is feasible only upon transition from the photographic method of flaw recording to the ionic method. One shortcoming of the latter method compared with the photographic one is low sensitivity of flaw detection and the impossibility of ascertaining the nature of the flaws in the inspected object.

Improved methods based on the utilization of ionic gamma defectoscopy with diverse variants of counters, from gas-discharge to scintillation ones, are as yet in the stage of laboratory development.

Practice shows that the most convenient type of gamma apparatuses for industrial inspection (quality control) are portable installations with low-activity preparations. At present the "Mosrentgen" /Moscow X-Ray Equipment Plant/, which produces installations for gamma exposure, has commenced the production of portable gamma installations.

In broad use are the methods of nondisruptive inspection based on the utilization of the characteristics of the processes occurring in the examined metal products subjected to the action of electric or magnetic fields.

One such method that has gained widespread acceptance is the magnetic powder method, which makes it possible to detect flaws (defects in compactness) in the surface layer of the material of a product and to assess the nature and dimensions of these flaws with a fairly sufficient accuracy.

The modern magnetic flaw finders are adapted for the maximal mechanization of all processes involved in the conduct of the inspection (magnetization, pouring of suspensions, demagnetization). The multiplicity of the problems posed by practice requires the development of flaw finders with a maximally universal range of applications. At the same time, however, it is in many cases also expedient to employ special-purpose flaw finders. The modern flaw finders (especially the general-purpose ones) are, as a rule, for the purpose of an improved detection of flaws, equipped with two magnetizing attachments -- one for magnetizing the inspected product circularly, and the other, for magnetizing it longitudinally. In the cases in which the appearance of variously oriented flaws is to be expected, it is best to employ the combined magnetization which makes it possible to magnetize the inspected products in continually varying direction.

A very important trend in the development of flaw inspection techniques has been the devising of the methods of the electron-ion guidance of flaw finders, the introduction

of which eliminates the hazard of drop-outs in the magnetization of the inspected products, because in this case the disconnection of the alternating, magnetizing current occurs during a rigorously definite and optimal phase. The method of electron-ion guidance makes it possible to simplify considerably and to cut the costs of the flaw finders and of the actual process of inspection, including the magnetization of products as well.

Year by year the dimensions of the inspected products increase, and this involves increasing difficulties in their magnetization and, especially, demagnetization. Obviously, it is not expedient to continue along the path of a further augmentation of the power ratings of the feeding transformers of flaw finders, and this problem can be resolved by devising pulsed flaw finders based on the slow accumulation of energy from the network and rapid discharge of the accumulating cell through the inspected product. The method of pulsed magnetization has been successfully incorporated in a domestically manufactured flaw finder of the capacitor type.

An important problem is the designing of a complex whole of industrial instruments for investigating the magnetic fields on the surface of inspected products, because the analytic calculation of these fields according to the available approximate formulas does not yield the needed results in a number of important practical cases.

In recent years there have appeared new methods of detecting the magnetic fields of scatter, fields which form around the sites of flaws in products, e. g., by means of searchers of a design analogous to that of a magnetic-recorder head. In the process of inspection, the searcher moves over the surface of the product and, when it passes over a flaw, it generates an e.m.f. pulse in its winding; this pulse is conveyed, after appropriate amplification, to the indicator device. In a number of cases it is more expedient to investigate the distribution of magnetic fields around a product part by the magnetographic method by means of a recorder tape impressed onto the surface of the product during the inspection. In the sites of concentration of magnetic lines of force the tape becomes magnetized more strongly, as is revealed by subsequent decoding of the magnetograph obtained on the tape. The decoding is conducted by means of a magnetic-recorder head moving relative to the tape. This method is successfully utilized in the USSR for the inspection of the welding of the tubes of gas and petroleum pipelines and, apparently, it can also be utilized in the machine building industry.

An essential influence on the development of electromagnetic flaw inspection has been exerted by the appearance

of the ferro-sounding methods of detection and measurement of small magnetic field or their gradients. These methods can be successfully utilized in designing automatic flaw finders, because of the high sensitivity and the feasibility of devising miniaturized sensors. It is to be emphasized that the sedimentation of powder particles requires as an indispensable prerequisite the presence in the region of the flaw of a sufficiently high magnetic-field gradient, which can be created only by surface flaws. At the same time, the presence of a magnetic field of scatter independent on the magnitude of the gradient of that field is a prerequisite for detecting flaws by means of magnetographic, ferro-sounding and other similar methods, and this makes it possible to utilize these methods also for detecting flaws located at depths of as great as 20-30 mm below the surface. Ferro-sounding methods are also successfully used in many other fields of defectoscopy -- for inspecting the thickness of nonferromagnetic sheet materials, inspecting hollow steel products, detecting ferromagnetic impurities in alloys, grading the products containing ferromagnetic impurities, etc.

Of great importance are the so-called structuroscopic methods, based on the measurement of electrical, magnetic, thermoelectric, and other physical characteristics. In the cases in which a sufficiently unambiguous relationship exists between the inspected structural-mechanical property and the measured physical characteristic, the expensive sampling inspections of mechanical properties can be successfully supplanted by the simpler, more rapid and nondamaging measurements of physical properties. The coercimetric instruments based on the use of the ferro-sounding method which makes it possible to automate the process of measurement have proved their worth.

In addition to coercimeters, industrial control practice broadly utilizes the instruments whose readings are proportional to remanent induction, magnetic permeability, magnetic saturation, etc. The development of these instruments is characterized by the trend for the maximal simplification, acceleration, and automation of the process of the flaw inspection of products.

An important place in modern flaw inspection is occupied by the electroinductive (or "eddy current") method, which is based on exciting eddy currents in the inspected section and measuring the back action of these currents on the exciting (or special measuring) coil. The electroinductive method is widely employed in practice, because it has been well investigated theoretically and experimentally. It is being successfully developed in the USSR.

This eddy current method has been used as the basis

for devising instruments for the contactless measurement of electric conductivity of materials, and for the detection of surface flaws in parts of nonmagnetic alloys, for the measurement of the thickness of nonelectroconductive coatings on nonmagnetic metals, and the like.

The electroinductive method is also utilized for structuroscopic purposes, for grading metals according to quality, detecting intercrystallitic corrosion, etc. This method is also of great importance ot the practice of experimental scientific research. Of great importance likewise is the circumstance that electroinductive instruments are easy to automate: at present we already know of models of automatic electroinductive flaw finders being used for inspecting the quality of small mass-produced parts and semi-finished products.

Many important problems of flaw inspection are being successfully resolved by means of the conventional "contact" method of measuring electric conductivity. This method will, in combination with the achievements of modern electronics, make it possible to carry out the automated inspection of the lamination of sheet materials, to verify the quality of the soldering, etc.

In the past few years considerable progress has been made in the luminescent and color methods of flaw inspection, based on the phenomenon of the capillary penetration of strongly wetting fluids into cracks, pores and other flaws in the continuity of the surface of inspected products. The luminescent method employs a fluid capable of glowing when exposed to ultraviolet light, and the color method -- an aniline dyestuff (sudan).

In the process of inspection the fluid penetrating into the flaws is extracted from the cavities of the flaws by means of the developing layer (fine-disperse powder in the luminescent method or a white pigment in the color method) superimposed onto the surface of the product, and it wets the contiguous particles of the developing layer. In this connection, inasmuch as the width of the area impregnated with the fluid is many times greater than the width of the "discovery" of the flaw, the previously invisible flaw becomes clearly visible to the naked eye (during ultraviolet lighting of the inspected part -- in the luminescent method, or on the background of the white pigment and at natural lighting -- in the color method).

The sensitivity of both methods is approximately identical and it can be assessed according to the width of the revealed cracks -- from 0.002 mm, and according to their depth -- from 0.05 mm. One essential advantage of this method is its applicability to not only metal but also non-

metal materials.

The ultrasonic methods of inspection began to be developed much later than the X-ray and magnetic ones, but at present they have already been greatly advanced. There exist five methods of inspection based on elastic vibrations within a broad frequency range of from 50 cycles to 25 megacycles: three ultrasonic -- the shadow, resonance and echo methods; and two acoustic -- the reaction and free vibration methods. These methods utilize four types of elastic vibrations -- longitudinal, shear, surface, and normal -- emitted continuously in the form of short pulses. The vibrations can be introduced into the inspected product by means of the dry-contact, contact-and-lubrication and immersion methods.

Such a large number of variables offers broad prospects for their various intercombinations and causes ultrasonic flaw inspection to be one of the most universal methods of flaw inspection. The gamut of products and materials permitting inspection by the methods of ultrasonic defectoscopy and the roster of flaws which they reveal are very long. The products executed of magnetic and nonmagnetic, metal and nonmetal (rubber, plastics, plywood) materials and their various combinations reveal, when inspected by ultrasonic methods, both depth and surface flaws, whether of three-dimensional, planar, linear or single-point nature, flaws which are constituted by breakdowns in continuity, inhomogeneity of grain or structure, zones of damage by intercrystallitic corrosion, imperfections in diffusive cohesion, cementing, soldering, i.e., any violation of the continuity of the acoustic characteristics of the inspected material. Special emphasis should be placed on the feasibility of a very accurate measurement of the geometric dimensions of products ar one-way access.

The vital problems of the development of ultrasonic defectoscopy consist in raising its efficiency, reliability and objectivity. These problems can be resolved only on the basis of automation of the inspection of monotype products by specialized installations.

Automation is easiest to introduce when operating with the shadow method. Specialized installations have been designed for inspecting solid shafts and cylinders, thicwalled tubes, bearing sleeves, laminated disks, cable-sheath seams, fine metal sheets, rubber balloons, etc. New prospects were unlocked for the shadow method in connection with the utilization of normal waves, which make possible a highly productive inspection of thin-walled sheets, thin-walled welded tubes, seamless laminated tubes and rods at one-way access. The employment of the shadow method is greatly

hampered by the absence of serial production of the necessary equipment.

The resonance method is successfully used for, mostly, measuring the thickness of tube walls, closed reservoirs, etc. However, the equipment manufactured for this purpose has become obsolete to a major extent and it requires major modernization or replacement. Of great importance is the incorporation, in the new equipment, of systems for direct indication of thickness, developed in the USSR, which make it possible to accelerate and automate the measurements.

The echo method has found broad application in industry for inspecting the most variegated products, which has to a major extent been assisted by the supplying (inadequate as it may be) of plants with echo flaw finders of various types. Principal products of the machine building industry and transport, and large special-purpose parts, including welded ones, are successfully inspected by the echo method.

However, the development of inspection by this method is braked by essential restrictions inherent in it when the contact-with-lubrication procedure is employed. This pertains primarily to the need for a high degree of purity of machining of the surface of the inspected product, a considerable "dead zone" in which flaws are not detectible, the impossibility of inspecting the products having a complex form, the need for a tight contact between the searching head and the surface of the product which leads to rapid wear of that head and complicates the automation of the inspection. In the past few years it has become possible to overcome these restrictions partially. Thus, the employment of surface waves has made possible the inspection of products having a very complex form for the presence of surface waves; the devising of searching heads with beryllium guards has made it possible to solve the problem of the wear resistance of these heads in the USSR; the use of polarized shear vibrations has made it possible to increase sensitivity of the inspection of products of materials with a high level of the automation of the inspection have also been developed and successfully tested.

However, many more opportunities are provided by the transition to the immersion procedure, which makes possible an easier automation. But in the USSR this procedure has not as yet been adequately mastered. In this case, naturally, the problem of the wear of searching heads is no longer important and, what is most important -- the transparency of the surface of the introduction of vibrations increases drastically. The requirements as to the purity of machining of the surface of a product can then be lowered by approximately three classes, or the degree of the purity of

machining of the surface of a product can then be lowered by approximately three classes, or the degree of the purity of machining can be kept the same, but the effectively introduced vibrations can be of a much higher frequency. This last circumstance makes it possible to increase the sensitivity of the method and to reduce the size of the "dead" zone, because it is determined by the duration of the sounding pulse, which at a high frequency can be curtailed more easily than at a low frequency.

The development of the immersion procedure abroad has proceeded along the path of increasing the frequency of ultrasonic vibrations (to 25 megacycles). Nonetheless, side by side with its advantages, this increasing of frequency has also its major disadvantages. The sensitivity of the procedure increases so greatly that at a 25-megacycle frequency it is possible to detect irregularities with a diameter of the order of 0.12 mm in steel or aluminum-alloy products. However, such a sensitivity is usually not needed for industrial flaw inspection, and besides, in practice, its attainment is hardly feasible, because it involves a steep rise in the level of structural noise, which requires an artificial reduction of sensitivity. Moreover, the damping of ultrasonic vibrations will then increase tremendously, and as a result it will not be possible to inspect products with large cross-sectional areas.

In the USSR the mastering of the immersion procedure has been proceeding along a distinctly more rational path, based on the use of low frequencies of the order of 0.5 to 5.0 megacycles, which ensure totally the sensitivity needed under industrial conditions. The "dead" zone decreases substantially because of the use of extremely short pulses produced by a special generator utilizing the principle of the compensation of vibrations and designed for an easy adjustment of pulse duration within a broad range of intervals. Moreover, provision is also made for the compensation of the pulse reflected from the front face of the inspected product, so that, as a result, the "dead" zone can in principle be completely eliminated. Laboratory tests of a device designed on the basis of the above representations have yielded excellent results. There exist foundations for assuming that the contact procedure for applying the echo method can be perfected in an analogous manner.

At present the most concrete problem is the designing of the models, and organization of serial production, of general-purpose echo flaw finders operating in the immersion and contact versions and displaying high technical characteristics (in particular, minimally small "dead" zone) and making it possible to carry out the automatic inspection of

monotype products and then to obtain an objective document -- a recording of the readings of the flaw finder. It can be stated that it is expedient to use such flaw finders as replacements for the currently used instruments of the obsolete types. This will make it possible to resolve more successfully and rapidly the complex problems involved in improving the quality of production.

The acoustic methods of reaction and free vibrations have but recently emerged from the stage of laboratory testing and have convincingly proved their worth in industry by making it possible to resolve a number of difficult problems which could not be fully resolved by ultrasonic methods. The most important task which affects the degree of utilization of these easily automatable methods is the designing of high-quality instruments and the organization of their serial production.

Thus, notable progress can be seen in the development of flaw inspection during the last few years. There appeared many new and original methods and devices making it possible not only to detect flaws but also to assess their size and nature.

At the same time, these new methods of inspection as a rule merely complement the old methods without supplanting them. It is hard to cite any method of inspection that may no longer be a concrete one at present.

Experience shows that the workers engaged in flaw inspection should be provided with instruments and installations based on the most variegated physical methods of inspection, in which connection, the variety and quality of these instruments and installations should increase and improve from year to year.

While at first the defectoscopists were expected only to ensure the necessary sensitivity of inspection, now they are also expected to ensure a high productivity of inspection, mechanization, and automation. The present-day stage of the development of flaw inspection is characterized by the transition from cottage-industry development and construction of isolated models of defectoscopic apparatuses to the centralized development and serial manufacture of such apparatuses in specialized instrument building enterprises. This transition should be carried out within the shortest possible period, because the further development of flaw inspection hinges on it.

2. Measures and Measuring Instruments Approved by the Committee, on the Basis of State Testing, for Use in the USSR

(As Recorded for September-October 1959)

/This is a translation of an article in Izmeritel'naya Tekhnika (Measurement Engineering), No.11, November 1959, pages 67-68; CSO:2900-N/8(11)./

An installation for determining the magnetic characteristics of thin-sheet electrotechnical steel, with plant symbol U578, Kievskiy Sovnarkhoz.

"Prokhodnyye" current transformers with precast insulation, with plant symbol TPL-10, Sverdlovskiy Sovnarkhoz.

An instrument for measuring the interelectrode capacitance of radio tubes, with plant symbol "PIMEL," Belorusskiy Sovnarkhoz.

Class II standard duplex saturated cells, L'vovskiy Sovnarkhoz.

Devices for measuring high d-c intensities, with plant symbol I505 Kievskiy Sovnarkhoz.

Rectification-system devices for telemetering the intensity of alternating current according to call, consisting of a KT-1 correcting transformer, a VU-1b rectifying device, and a TM-A2 or PMDG receiving device, Leningradskiy Sovnarkhoz.

Induction-rectification-system devices for telemetering steam pressure, consisting of a manometer with a MPI-1 induction converter, a SN-1 or NE-120-0.1 voltage stabilizer, a VU-1a rectifying device, and a TM-A2 or PMDG-1 receiving device, Leningradskiy Sovnarkhoz.

Rectification-system devices for telemetering the intensity of alternating current, consisting of VPT-1a rectifying voltage converter and a TM-A2 or PMDG-1 receiving device, Leningradskiy Sovnarkhoz.

Induction-rectification-system devices for telemetering the intensity of three-phase current, consisting of a VAPI-2 wattmeter converter, a TM-A2 or PDMG receiving device, a VU-1a rectifying device, and a SN-1 voltage stabilizer, Leningradskiy Sovnarkhoz.

A medical roentgenometer for measuring the doses of X- and gamma-radiation, with plant symbol RM-1M, Belorusskiy Sovnarkhoz.

Portable multi-range d-c microamperemillivoltmeter

recorders with plant symbol N-373, Krasnodarskiy Sovnarkhoz.

D-c bridge installation, with plant symbol U-303, Krasnodarskiy Sovnarkhoz.

Protable avometers, with plant symbol PR-5, Ministry of Communications USSR.

Calibrated portable shunts, with plant symbol R81/5-9, Leningradskiy Sovnarkhoz.

Attachment to the horizontal optimeter -- horizontal centers, with plant symbol PP-3, Leningradskiy Sovnarkhoz.

Automatic saccharimeters, with plant symbol SA-2, Kievskiy Sovnarkhoz.

Secondary midget pneumatic indicating instrument, with plant symbol 1MP-30A, for measuring a single variable, Moscow City Sovnarkhoz.

Secondary midget pneumatic indicating instrument, with plant symbol 2MP-30V, for measuring a single variable and for indicating the magnitude of setting and pressure on the actuating mechanism, Moscow City Sovnarkhoz.

Secondary midget pneumatic recording instrument, with plant symbol 1RL-29A, for recording a single variable Moscow City Sovnarkhoz.

Secondary midget pneumatic recording instrument, with plant symbol 2RL-29B, for recording two variables, Moscow City Sovnarkhoz.

Secondary midget pneumatic recording instrument, with plant symbol 3RL-29V, for recording a single variable and for indicating the magnitude of setting and pressure on the actuating mechanism, Moscow City Sovnarkhoz.

An installation with a master piston-loaded discharge-I manometer, with plant symbol UPM-6, for calibrating piston-loaded manometers for up to six kgs/cm^2, Latviyskiy Sovnarkhoz.

Capacitor box, with plant symbol R513, Kievskiy Sovnarkhoz.

Portable weight scale, with plant symbol VPG-1(m), Khar'kovskiy Sovnarkhoz. Unified with the previously approved portable weight scale with plant symbol VPG-2(m).

3. New Instruments for Determining the Composition of Matter

/This is a translation of an article written by I. M. Rubinshteyn and G. A. Simonyan in Priborostroyeniye (Instrument Building), No.10, October 1959, pages 26-30; CSO:2900-N/8(12)./

The SKBPSA (Independent Bureau for Designing Instruments and Means of Automation) is developing new automatic instruments and means of automation (pH-meters, photocolorimeters, nephelometers, smoke gauges, dust counters, conductometers) for determining the recording and regulation of acidity, alkalinity, salinity, and concentration of matter in solutions and aerosols.

These instruments are designed for the control and regulation of technological processes in the enterprises of the chemical, light, papermaking, food, metallurgical and other branches of industry, as well as in agriculture.

The following is a brief survey of the instruments subject to mastering for serial production in 1959-1960.

Portable PShP-58 Rod Type pH Meter

The PShP-58 type instrument (Fig. 1) is designed for isolated control measurements of the active concentration of hydrogen ions in technological aqueous solutions under industrial conditions.

The design of this instrument, providing for an immersible probe, makes it possible to conduct measurements directly in the shop (vats, tanks, tubs, etc.).

The measurement is conducted by immersing into the inspected solution the lower part of the rod of the instrument, to which the probe is attached.

Designwise the PShP-58 pH-meter consists of three main units: instrument head, carrying a M-24 microammeter graduated in pH units and a measuring circuit, rod with removable casing containing supply batteries, and probe of pH value with protective casing and removable receptacle.

Principal Specifications of the PShP-58

Limits of measurement, in pH units	2-12
Limit of manual temperature compensation, in °C	5-65
Error of measurement, in pH units:	
Within the limits of 2 to 9	±0.1
" " " " 9 " 12	±0.2

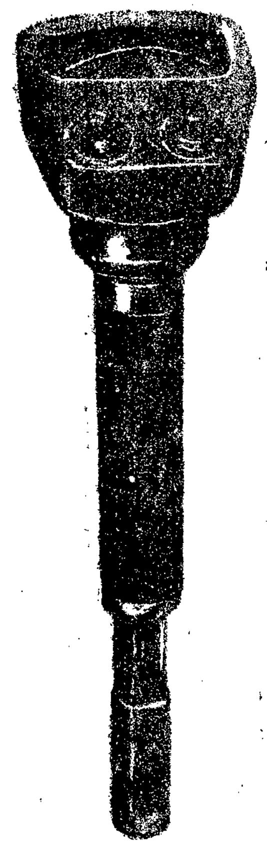

Fig. 1. Portable PShP-58
Rod Type pH Meter

The instrument is powered by dry cells.

The set of power supply sources consists of a 19-PMGTs-0 type anode battery with an initial e.m.f. of 19 volts and a "Saturn" 1-KS-U-3 type filament unit with an initial e.m.f. of 1.6 volts.

Dimensions of the instrument: height (with electrode) -- 485 mm; diameter of immersed part of probe -- 27 mm. The weight of the instrument does not exceed 1.5 kg.

The PShP-58 type pH meter's production is being mastered in the enterprises of the Georgian and Belorussian SSRs.

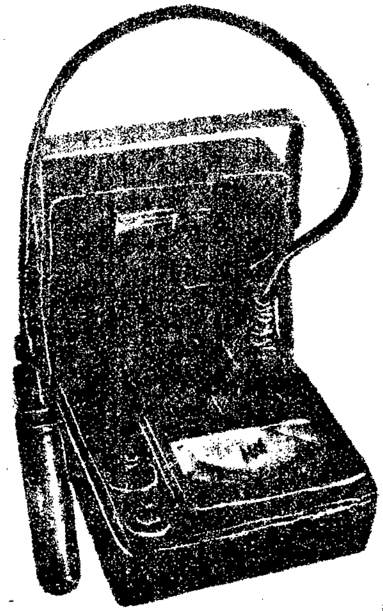

Fig. 2. The PPP-58 Field Soil pH Meter.

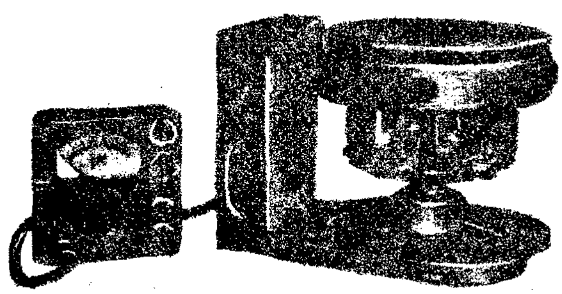

Fig. 3. Complete Set of the PLP-58
Laboratory Soil pH Meter.

The PPP-58 Type Field Soil pH Meter

This instrument (Fig. 2) is designed for the conduct of isolated measurements of the active concentration of hydrogen ions in the saline extracts of soils.

The design of the PPP-58 pH meter makes it possible to conduct measurements both directly under field conditions and under laboratory conditions.

In addition to its applications in various fields of agricultural engineering this instrument can also be applied in a number of other branches of the national economy in which the determination of the acidity of soils is a must, e. g., in land reclamation, hydraulic engineering, geology and hydrogeology.

The instrument consists of two main units: (a) data pickup with connecting cable and joint; and (b) measuring device.

The data pickup is constituted by a composite glass electrode mounted in a plastic holder and connected to the measuring circuit of the instrument by the connecting cable and joint.

The upper panel of the casing of the instrument holds a micrometer with a dial graduated in pH units, a zero adjustment lever, a temperature condensation lever, slotted shafts from potentiometers (installed at the beginning and end of the dial), and a joint for connecting the data pickup.

The instrument is powered by midget galvanic batteries installed in the casing of the instrument.

Thanks to the presence of manual temperature compensation, the instrument's readings do not change with a changing temperature of the probe.

A distinctive feature of the circuit is the possibility of correcting the mode of performance of the tubes according to the changing battery voltage, which appreciably prolongs their service life (until replacement).

Principal Specifications of the PPP-58

Limits of measurement, in pH units	3-10
Error, in pH units	± 0.1
Limits of temperature compensation, in $^{\circ}C$	10-30
Dimensions, in mm	200x210x105
Weight, in kg	2.75

The production of this instrument is being mastered by enterprises of the Belorussian SSR.

PLP-58 Type Laboratory Soil pH Meter

The pH meter of this type (Fig. 3) is constituted by a multiple-probe instrument with glass electrodes, and it is designed for the (multiple) conduct of measurements of the pH value of soils in oblast and zonal laboratories of agricultural chemistry.

The measurement is conducted by mounting the receptacles (with soil suspensions in calcium chloride solution) into the cells of the multiple-electrods probe unit.

The complete set of the instrument consists of a multiple-electrods unit and a measuring device.

The multiple-electrode unit consists of eight probes and eight stirrers. The rotation of the multiple-electrode unit and its stirrers is carried out through a ShE-IX type electric motor with the control of the RPM by a rheostat. The probe consists of a composite electrode in a plastic protective mount. The entire circuit of the multiple-electrode unit is tightly sealed and shielded. The unit is connected to the measuring device by a cable and joint. The design of the electrode makes it possible to easily remove the soil particles adhering to it.

The measuring instrument consists of a PPP-58 field soil pH meter, and a PLP-58 pH meter designed for use with standard receptacles holding as much as 200 cm^3. Manual compensation of temperature is provided for.

Principal Specifications of the PLP-58

Limits of measurement, in pH units	3-10
Error, in pH units	± 0.1
Limits of temperature compensation, in °C	10-30
Dimensions, in mm	500x500x400
Weight, in kg	16

The instrument is powered from dry sources -- a 1-KS-U-3 cell and a 19-PMGTs-0 battery.

The productivity of the instrument reaches 1,000 measurements per shift (under two operators).

The production of this instrument is being mastered in the Belorussian SSR.

The AEP-58 Type Automatic Electronic pH Meter

The AEP-58 automatic electronic pH meter (Fig. 4) is used for measuring, recording and regulating the concentration of technological solutions in the textile industry.

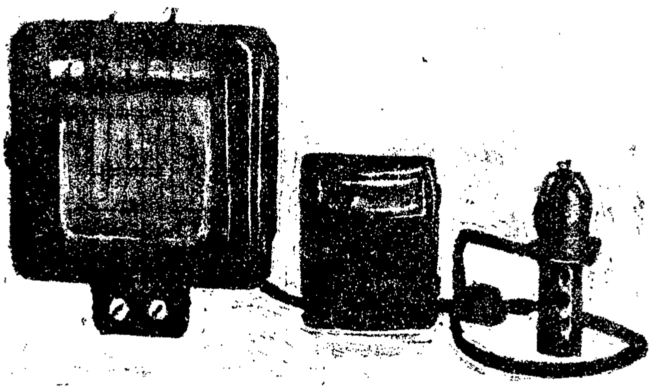

Fig. 4. Complete Set of the AEP Type Automatic Electronic pH Meter.

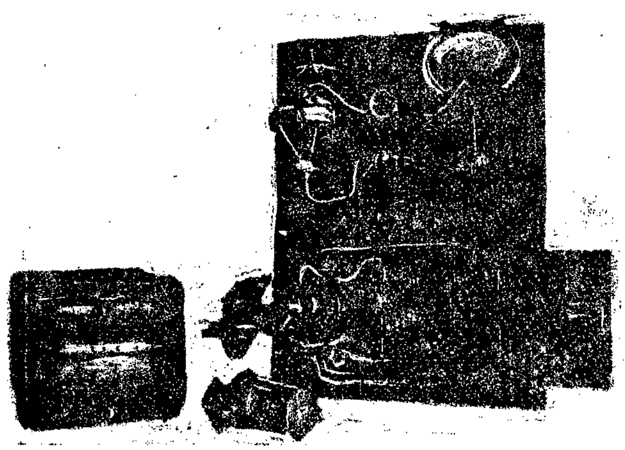

Fig. 5. Complete Set of the AFK-57 Automatic Photocolorimeter.

The complete set of the automatic electronic pH meter consists of a probe of the pH value, a PVU pH meter unit (developed by the TsLA) [Central Laboratory of Automation], and an EPP-09 automatic electronic potentiometer.

The electromotive force arising when the probe is plunged into the solution is transmitted to the input of the PVU and thence to the input of the EPP-09 with a pneumatic isodromic regulator.

The effect of changes in temperature of the solution is compensated for by a temperature compensation potentiometer mounted on the PVU pH meter unit.

The probe consists of a frame to which a glass electrode and a reference electrode are attached, a protective casing sheltering the electrodes from mechanical damage, and a removable lid covering the internal cavity of the probe.

The glass electrode and the reference electrode are placed in special packing glands which are tightly sealed and exclude the penetration of the measured solution inside the frame.

At its top the body of the probe is covered with a removable lid which can be tightly clamped on and rapidly removed by means of a yoke, a clamping chock and a wing nut. To remove the residual moisture in air, a silica gel cartridge is inserted into the probe casing.

The probe casing is provided with a fastening collar. A stopper for the KCl solution is provided in the upper part of the reference electrode.

The cable of the probe is attached to the main cable through a hermetized box.

Principal Specifications of the AEP-58

Limits of measurement, in pH units	1-8
Range of operating temperatures, in $^{\circ}C$	20-60
Dimensions of secondary instrument, in mm	507x483x387
Dimensions of probe, in mm	355x130x130
Weight of probe, in kg	2.9
Weight of entire apparatus, in kg	50

The main error of readings does not exceed two percent of the range of measurements.

The supplementary error ensuing from measurement of the temperature of the measured medium and ambient air is not higher than 0.5 percent for every $10^{\circ}C$, beginning from $+20^{\circ}C$.

The AEP set is powered from an a-c system with a voltage of 127/220 volts and a frequency of 50 cps.

The production of this apparatus is being mastered in an enterprise of the Georgian SSR.

The AFK-57 Type Automatic Photocolorimeter

The photocolorimeter (Fig. 5) is designed for the continuous automatic measurement and recording of the optical density of alkalis ("chromaticity") in the process of the boiling of sulfite pulp, and also for signaling on the ending of the boiling process.

The principle of performance of this instrument is based on the photocolorimetric comparison of light absorption by the measured solution with the standard absorption. The FS-K1 photoresistors, which display high sensitivity in the required spectrum range, are used as light-ray receivers.

The instrument is assembled according to a differential circuit ensuring the accuracy and stability of readings. The compensation of circuit unbalance during the measurement is conducted according to the luminous flux by means of a circular optical wedge installed in the working arm of the optical part of the instrument. The secondary instrument is constituted by an appropriately modified PSR1-01 automatic electronic potentiometer. The connection between the adjustable motor of the secondary instrument and the optical wedge of the probe is carried out by a selsyn couple. The probe of the instrument is equipped with a cuvette.

The instrument is graduated in relative units from 0 to 100 percent with a gradation of 2.5 percent. If necessary, the instrument is supplemented with a table for converting the gradations on the dial to units of optical density.

The complete set of the instrument includes probes, a PSR1-01 secondary instrument (with modified circuit), an "alkali"-feeding unite, and a 220/127-volt distribution-network transformer.

The probe consists of three main units: casing, angle bracket and power-supply unit.

The alkali-feeding unit ensures the continuous feed of alkali into the cuvette with a time lag of not more than one minute.

All parts of the feeding unit are located on a panel.

Principal Specifications of the AFK-57

Main error of readings, in percent of maximum value on the dial	±5
Recording of readings on a strip chart having the length, in mm, of	160
Threshold of sensitivity, in percent of maximum value on the dial, is not more than	2

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(Continued from Page 21)

Principal Specifications of the AFK-57

Dial length, in mm	160
Power consumed, in volt-amperes	140
Dimensions of the panel for placing the probe with alkali-feeding unit, in mm	600x800x80
Dimensions of secondary instrument, in mm	350x287x404
Weight of complete set, in kg	up to 60

When the feed voltage changes by ±10 percent and the frequency by ±1 percent from their nominal values, the reading error of the instrument does not exceed the principal error.

The instrument is powered by an a-c system of 127 volts and frequency of 50 cps. When the 220-volt system is used, it is necessary to apply a 220/127-volt step-down distribution transformer.

The ARDM-58 Automatic Regulating Smoke Gauge (Fig. 6)

The smoke gauge is designed for the continuous measurement, recording and regulation of the density of smoke in the chambers for the cold and hot curing of fish and meat products.

The instrument is based on the method of comparing the values of two currents passing through the working and the compensating photoresistors, respectively.

The probe operates according to the principle that smoke density can be expressed by optical density per unit length and is independent of the length of the luminous flux in smoke. This has made it possible to employ the principle of light absorption for graduating the instrument in absolute units of optical density.

The secondary instrument is assembled on the basis of a midget automatic electronic potentiometer. Smoke density is read on the dial of the instrument. The automatic recording mechanism conducts a continuous recording of smoke density on a strip chart.

The dial is graduated in relative units from 0 to 100; in addition, the instrument is provided with a table for converting dial units to optical density units.

The regulation of smoke density is carried out by means of a throttle valve with an electric actuating mechanism.

The instrument is provided with an attachment for signaling on any insufficiency of smoke in the curing chamber.

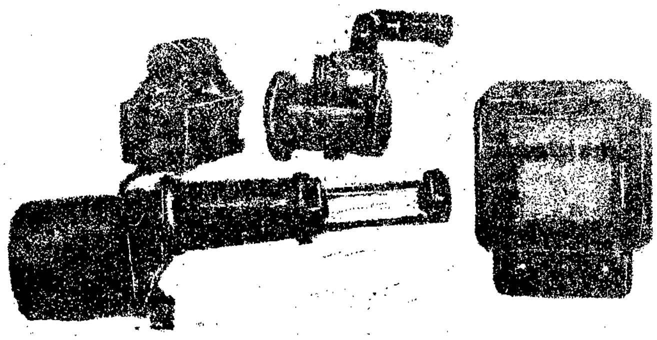

Fig. 6. Complete Set of the ARDM-58 Type Automatic Regulating Smoke Gauge.

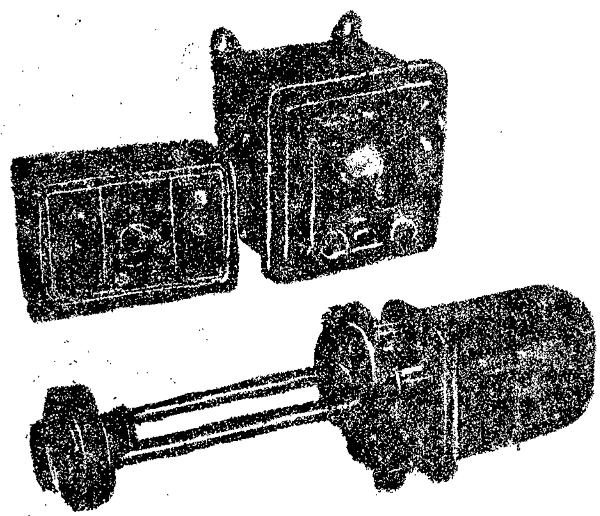

Fig. 7. Complete Set of the ASV-58 Automatic Fogginess Indicator.

Principal Specifications of the ARDM-58

Principal error of readings, in percent of the range of measurement	± 2
(Nominal) dial of instrument, in percent of smoke content in the curing chamber	0-100
Time of heating of protective glass, in minutes	not over 20
Time of transit by pointer over the entire length of the dial, in seconds	not over 8
Length of dial, in mm	160.
Rate of advance of strip chart, in mm/hour	20; 40; 60; 80; 120; 180; 240; 360; 480; 720; up to 720
Power consumed, in volt-amperes	up to 500
Dimensions of secondary instrument, in mm	330x387x404
Weight of entire apparatus, in kg	25

When the feed voltage changes by ± 10 percent and the frequency by ± 1 percent from their nominal values, the reading error of the instrument does not exceed the principal error.

The complete set of the instrument includes a probe, a secondary instrument with a miniature control panel (based on a PSR1-03 type potentiometer), a regulating organ with an actuating mechanism, and a power-supply unit.

The production of the instrument is being mastered in an enterprise of the Georgian SSR.

The ASZ-58 Type Automatic Fogginess Indicator

The ASZ-58 instrument (Fig. 7) is designed for signaling on the appearance of undesirable sulfur trioxide SO_3 in the sulfur dioxide of the sulfite pulp industry.

This photoelectric-type indicator, thanks to the adopted auto-collimation system of its optical unit, displays a high sensitivity and is activated by the appearance of any appreciable fog, which corresponds to approximately three or four percent of light absorption (light absorption by pure white polished glass, two or three mm thick, amounts to seven to 10 percent.

The instrument makes it possible to vary the base of the indicator within broad limits and to pre-set its triggering threshold in accordance with local conditions. The dial of the setter is graduated in relative units from 0 to 100 percent. The instrument is also calibrated in units of optical density.

The optics of the instrument is protected by the electric heating of protective plates coated with a semiconductor current-conducting layer which prevents the condensation of the vapors of moisture and sulfuric acid thereon.

The ASZ-58 automatic indicator of the fogginess of sulfur dioxide was developed upon instruction of the Central Scientific Research Institute of the Paper Industry, but it can find application also in the other branches of industry which experience the need for instruments for the automatic signaling of the appearance of traces of fog, smoke, dust, etc.

Principal Specifications of the ASZ-58

Principal Error of Triggering Threshold, in percent of the Instrument's Dial	± 5
Complete angle of turn of the setter's lever (from 5 to 100 percent on the dial) in ^{o}C	270
Power consumed, in volt-amperes	up to 200
Weight, in kg	30

The setter's dial is graduated in units of light absorption: on the dial 10 percent corresponds to 8.5 percent of light absorption, and 100 percent, to 85 percent of light absorption.

When the feed voltage changes by ± 10 percent and the frequency by 1 percent, from their nominal values, the reading error of the instrument does not exceed the principal error.

The instrument is powered by an a-c system of 127 volts and a frequency of 50 cps, through a 220/127-volt distribution transformer.

The complete set of the instrument includes a sensor (dimensions: 690x300x186 mm; weight: 7.0 kg), an amplifier (dimensions: 232x252x288 mm; weight: 5.0 kg), a control unit (dimensions: 275x180x195 mm; weight: 2.4 kg), and a distribution transformer.

The production of this instrument is being mastered in an enterprise of the Georgian SSR.

The AKSD-57 Automatic Shipboard Smoke Indicator

This instrument is used for signaling the appearance of smoke in the cargo accommodations of dry-cargo vessels (holds and 'tween-decks) and it serves as one of the devices for providing early fire warning.

Fig. 8. The AKSD-57 Automatic Shipboard Smoke Indicator.

The indicator is installed in the ship's wheelhouse, and it serves to control simultaneously as many as eight accommodations.

This instrument can be applied in every case in which an automatic fire alarm system is needed (storage accommodations, clubs, theatres, etc.).

The complete set of the instrument consists of a signalling device and a ventilating installation continuously drawing air out of the premises through a system of radial pipes and through the sensor of the signalling device and a visual chamber.

When smoke appears in the system, the signalling device is triggered and emits sound and light signals. The number of the accommodation in which the smoke originated is determined by examining the cells of the visual chamber.

The instrument's sensor is of the photoelectric type; it displays a high sensitivity and is triggered when the luminous flux decreases by five percent.

The instrument's power supply comes from an a-c system of 220/127 volts and a frequency of 50 cps.

The instrument can operate under the conditions of the fluctuations of temperature from minus 20 to plus 50°C, at a humidity of as much as 98 percent, and during vibrations and jarrings.

The dimensions of the signalling device are 900x1,650x540 mm, and its weight is 203 kg. The dimensions of the ventilating unit are 1,460x830x660 mm, and its weight is 207 kg.

The production of this instrument is being mastered in an enterprise of the Georgian SSR.

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